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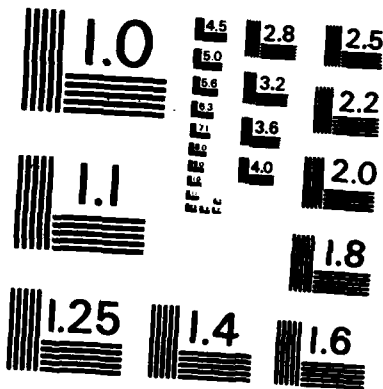
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SPACE-BASED WEAPONS,
AND THE DEFENSE OF THE WEST**

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US ARMY WAR COLLEGE
Carlisle Barracks, Pennsylvania**

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**BALLISTIC MISSILE DEFENSE,
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by

Daniel S. Papp

15 November 1983

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FOREWORD

This memorandum examines the many issues related to the technical feasibility and future deterrent utility of ballistic missile defense (BMD). The author contends that BMD clearly presents American and Western security planners with a staggering number of possibilities. The author concludes, however, that uncertainties pertaining to future BMD technologies, the unknown constraints of deployment, and the potential costs make acquisition decisions highly problematic. Neither proponents nor opponents of space-based, land-based, or layered BMD systems have presented evidence that drives one to unambiguous final conclusions.

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This memorandum was prepared as a contribution to the field of national security research and study. As such, it does not reflect the official view of the College, the Department of the Army, or the Department of Defense.

Thomas F. Healy
THOMAS F. HEALY
 Major General, USA
 Commandant



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BIOGRAPHICAL SKETCH OF THE AUTHOR

DANIEL S. PAPP, Ph.D., is Professor of International Affairs and the Director of the School of Social Sciences at Georgia Institute of Technology and was formerly a Research Professor at the Strategic Studies Institute of the US Army War College. A graduate of Dartmouth College, he received his doctorate in international affairs at the University of Miami's Center for Advanced International Studies. During the academic year 1983-1984, Professor Papp has served as a Senior Research Fellow at the Airpower Research Institute of the Air University. He has published and lectured widely on international affairs.

SUMMARY

In his March 23, 1983 address on military spending, President Ronald Reagan presented his vision of a future in which American defenses could "intercept and destroy strategic ballistic missiles before they reached our own soil or that of our allies." To achieve this objective, Reagan directed that a "comprehensive and intensive effort" be undertaken to define a long-term research and development program designed to "achieve our ultimate goal of eliminating the threat posed by strategic nuclear missiles."

Public reactions to Reagan's proposal were rapid and diverse. Critics reviled strategic defense as a dangerous delusion, and claimed that it was technically unfeasible, economically too costly, strategically destabilizing, and militarily unsound. Proponents of the concept argued that existing technical difficulties could be overcome; that costs were a minor constraint when ultimate security was at stake; and that space-based defenses were a solution to the seemingly perverted logic of mutual assured destruction. Whatever the actual merits of his proposal, Reagan had undeniably generated more public debate on a high technology defense issue than had been heard for years.

Reagan's address did more than generate public debate over the wisdom of strategic defense. Since the early 1950's US nuclear deterrence policies had been based at least in part on the assumption that no effective defense against nuclear attack existed. Reagan's speech challenged that assumption and forced strategic analysts once again to ask questions that they had believed were satisfactorily answered. What if strategic defense with little or no leakage became a possibility? Would it be stabilizing or destabilizing in a crisis situation? Would it lead to a defensive arms race, and would it accelerate the offensive arms race? What would be the implications for the strategic balance and for the future of deterrence if one side achieved a low-leakage or no-leakage strategic defense before the other? What if both sides achieved such a defense simultaneously, or if one or both sides achieved only a high-leakage defense? How would any strategic defense impact the allies of the superpowers, and how would arms control be affected?

The author concludes that the uncertainties pertaining to future BMD technologies, the unknown constraints of deployment and

the potential costs of deployment make judgements concerning the acquisition of BMD systems difficult. Neither proponents nor opponents of space-based, land-based, or layered BMD systems have presented evidence which leads to unambiguous conclusions concerning the potential utility of such systems.

BALLISTIC MISSILE DEFENSE, SPACE-BASED WEAPONS, AND THE DEFENSE OF THE WEST

In his March 23, 1983 address on military spending, President Ronald Reagan presented his vision of a future in which American defenses could "intercept and destroy strategic ballistic missiles before they reached our own soil or that of our allies." To achieve this objective, Reagan directed that a "comprehensive and intensive effort" be undertaken to define a long-term research and development program designed to "achieve our ultimate goal of eliminating the threat posed by strategic nuclear missiles." Although Reagan's address itself contained no references to specific strategic ballistic missile defense (BMD) technologies, it was apparent to many that his vision of a future free of the terror of nuclear weapons was based on the development and deployment of beam technology weapons such as lasers, particle beams, and microwaves.

Public reactions to Reagan's proposal were rapid and diverse. Critics reviled strategic defense as a dangerous delusion, and claimed that it was technically unfeasible, economically too costly, strategically destabilizing, and militarily unsound. Proponents of the concept argued that existing technical difficulties could be overcome; that costs were a minor constraint when ultimate security was at stake; and that space-based defenses were a solution

to the apparent weakness of the current offensive, force dominant deterrence posture.² Whatever the actual merits of his proposal, Reagan had undeniably generated more public debate on a high technology defense issue than had been heard for years.

Reagan's address, however, did more than generate public debate over the wisdom of strategic defense. Since the early 1960's, US nuclear deterrence policies had been based at least in part on the assumption that no effective defense against nuclear attack existed. Reagan's speech challenged that assumption and forced strategic analysts to reexamine questions they believed had been satisfactorily answered.³ Could strategic defense with little or no leakage (i.e., no penetration by enemy warheads) be achieved? Would it be stabilizing or destabilizing in a crisis? Would it lead to a defensive arms race and would it accelerate the offensive arms race? What would be the implications for the strategic balance and for the future of deterrence if one side achieved a low-leakage or no-leakage strategic defense before the other? What if both sides achieved such a defense simultaneously, or if one or both sides achieved only a high-leakage defense? How would any strategic defense affect the allies of each superpower, and how would arms control be affected? This paper will examine these and other related questions.

First, however, a clarification of terminology used throughout this paper is appropriate. Although President Reagan's so-called Star Wars proposal referred primarily to beam weapons (also known as directed energy transfer (DET) weapons), other defensive technologies do exist. Some are nearer operational status than DET weapons. Certain types of antiballistic missiles (ABMs) may be operationally tested by 1985—this form of BMD uses missiles to destroy incoming ICBMs. Thus, both DET and ABM technologies are subsets of BMD,⁴ and both can be either space-based or land-based.

Indeed, according to some strategists, a layered BMD system employing, for example, space-based DET weapons and ground-based ABM capabilities, could reduce or eliminate any leakage problem that an exclusively space-based DET system may have. More ambitious layered BMD systems project space-based defense systems coupled with both a ground-based non-nuclear exoatmospheric (i.e., above the atmosphere) ABM capability.⁵

Conversely, development of effective antisatellite (ASAT) capabilities may negate the utility of DET or conventional space-

based defenses. Therefore, it is appropriate that this effort also investigate the potential impacts that other technologies such as ABMs and ASATs may have on the calculus of strategic deterrence if and when DET weapons become operational. First, however, it may be helpful to present an overview of the American BMD and military space programs.

AN OVERVIEW

To those familiar with the Reagan administration's record in the areas of ballistic missile defense (BMD) and space, the President's March 23 address on strategic defense offered few surprises. It had been evident for some time that the Reagan administration was intensely interested in BMD and active military uses of space.

BMD Technologies. American BMD efforts were substantially deemphasized following the signing of the 1972 ABM Treaty and the 1974 ABM Protocol.⁶ During the late 1960's, US ABM expenditures averaged approximately \$1 billion per year (in FY 1980 dollars). By 1980, expenditures on strategic defense had fallen to \$100 million.⁷

Shortly thereafter, however, American interest in BMD and active space-based military systems increased as technical advances, the collapse of detente, and changes in political leadership altered the prevailing strategic environment. Technical breakthroughs in radar, high-speed computers, boost technologies, command, control and communications (C³) abilities, and laser capabilities increased the feasibility of both ABM and DET BMD. The recent successful destruction of five 2,000-miles-per-hour Sidewinder missiles by an airborne high energy laser clearly indicated that DET technologies had progressed substantially. Meanwhile, traditional ABM technologies also showed promise, perhaps most notably with the US Army's small radar homing interceptor (SR Hit) program, currently being developed by Vought and scheduled to be flight tested in 1985.⁸

Active Military Technologies in Space. As with BMD capabilities, significant studies had been undertaken during the 1970's in technologies designed for military use in space. Space, of course, had been used in a largely passive manner by both the United States and the Soviet Union for military purposes almost since the beginning of the space age. By the early 1980's, the military establishments of several countries, but especially the

United States, had become highly dependent on orbiting space systems for strategic and tactical communications, navigation, surveillance, reconnaissance, early warning, and weather reporting purposes. One measure of the importance that space communications had attained in the American military was revealed during the abortive raid to rescue American hostages in Iran during 1980. Then-President Jimmy Carter was in direct contact from Washington via satellite with American forces on the ground in Iran, and personally aborted the raid. A second example is more mundane but perhaps more illustrative: each month a single US Navy carrier battle group sends or receives over forty thousand satellite-carried messages.⁹

One reason that space has rarely been used for active military purposes was the 1967 "Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, Including the Moon and Other Celestial Bodies," also known more conveniently as the "Outer Space Treaty." This multilateral international agreement prohibited placing "nuclear weapons or any other kinds of weapons of mass destruction" into space. Other treaty provisions included agreements to explore and use space "in the interest of maintaining international peace and security" and denial of all claims of sovereignty over outer space, the moon, and other celestial bodies.¹⁰ Other factors have also led to a limited active military presence in space. These factors included a generally prevailing public sentiment that space should be recognized as a zone of peace, and recognition that technical limitations of available space hardware permitted few active space-based military undertakings.

Nevertheless, some active military uses of space have been explored. One area that was under investigation during the 1960's and 1970's was antisatellite (ASAT) weaponry. Put simply, an ASAT is any weapon that can destroy or degrade the operation of a satellite. An early US ASAT program sought to develop the capability to destroy an enemy satellite by launching an explosive satellite into an orbit identical with the target. This coorbital approach, also favored by the USSR, was abandoned by the United States in favor of a direct ascent system called the "Air Launched Miniature Vehicle" (ALMV). The ALMV is launched by a high-flying F-15 at a satellite passing overhead in low earth orbit. The purpose of the ALMV is to "intercept Soviet satellite systems and to deter Soviet first use of their antisatellite weapon."¹¹ The Soviet

Union, meanwhile, had developed a rudimentary coorbital ASAT system, and was working on DET weapons including lasers and particle beams.

When viewed from a Soviet perspective, the US space shuttle also has ASAT and BMD potential. During the US-USSR ASAT negotiations, terminated in December 1979 by the United States in response to the Soviet invasion of Afghanistan, the USSR regularly insisted that the United States suspend development of the space shuttle because of its potential use in antisatellite operations.¹² Other analysts have observed that the space shuttle itself as well as follow-on technology could be used to deploy, maintain, and service orbital BMD systems. Beyond whatever potential ASAT and BMD utilities the shuttle may have, it does have clear reconnaissance, surveillance, communications and satellite-launching operations. The military potential of the shuttle is perhaps best indicated by the number of military space shuttle launches, which although in fiscal year 1983 was zero, is projected to increase in fiscal year 1987, with six launches completely dedicated to military purposes and seven launches each of one-fourth military dedication.¹³

To date, no space-based BMD has been developed or tested. As emphasis on BMD grows, however, research and development will almost inevitably follow. Indeed, the Reagan administration itself had already undertaken a number of organizational changes, doctrinal pronouncements, and policy initiatives on BMD and related space-based military activity throughout its tenure.¹⁴ These changes, pronouncements, and initiatives when viewed in conjunction with the President's March 23 address are clear indications of the Reagan administration's interest in BMD and the military utility of space.

Reagan, BMD, and the Military Utility of Space. The Reagan administration's interest in BMD and space appeared as early as spring of 1981 when the Department of the Air Force formed a new Space Laser Office. In September 1981, the Deputy Chief of Staff for Plans and Operations of the Air Force created the Directorate for Space. The following month, President Reagan himself verbally supported the development of technologies needed for space-based defense. Secretary of Defense Caspar Weinberger agreed with Reagan in the 1982 Defense Guidance issued in March and subsequently "leaked to the press, declaring that the United States should "exploit opportunities through the use of space for

increasing deterrence at all levels of conflict." He also directly addressed space-based weapons, calling for development of prototypes "so that we will be prepared to deploy fully developed and operationally ready systems should their use prove to be in our national interest."¹⁵ Shortly thereafter, in April 1982, the General Accounting Office (GAO) issued a report that added momentum to the push to develop laser, particle beam, and microwave weaponry, observing that such technologies could "revolutionize military strategy, tactics, and doctrine." The GAO report urged the Pentagon to accelerate its laser research and development.¹⁶

In June, the Department of Defense finalized its own space policy statement, and following the successful July 4th landing of the fourth space shuttle mission, Ronald Reagan issued his own national space policy statement. According to press released reports, Reagan's space policy contained several phrases that clearly pointed to accelerated American military activity in space; for example:

Purposeful interference with space systems shall be viewed as an infringement upon sovereign rights. . . .

The US space program will comprise two separate, distinct, and strongly interacting programs. . . .

The US will pursue activities in space in support of its right of self-defense. . . .¹⁷

Within a few months, the US Air Force created its Space Technology Center at Kirtland Air Force Base and operationalized its Space Command on September 1st of the same year. The Space Command's responsibilities included operating military space shuttle flights; maintaining surveillance, warning, and weather satellites; developing US ASAT capabilities; and conducting research on DET weapons. Also in September 1982, according to reports, Caspar Weinberger met with Alan Pike, the Acting Director of the Directed Energy Office of the Defense Advanced Research Projects Administration, and was informed that within 5 years the United States could deploy a rugged and survivable space-based laser that would be capable of defending itself. The following month, the Air Force finalized its space doctrine manual.¹⁸

Discussions of BMD and space-based defense continued within the Reagan administration, with BMD, reportedly, being a major

issue of discussion at a February 1983 meeting of the Joint Chiefs of Staff.¹⁹ Weinberger released *The 1983 Defense Guidance* in March which, according to accounts, stressed the military's role in space. As reported by Richard Hallován of *The New York Times*, the guidance for US systems had to:

- ... assure robust support to nuclear and conventional forces.
- ... negate enemy use of space systems to support forces hostile to the United States.
- ... provide a credible defense of United States space assets.
- ... protect associated terrestrial functions from hostile space supported actions.²⁰

Increased American emphasis on BMD and military uses of space under the Reagan administration may be tracked by budgetary analysis as well. The Department of Defense's requests for space appropriations climbed from about \$3.9 billion in fiscal year 1980 to \$4.7 billion in 1981, \$5.8 billion in 1982, and \$8.5 billion in 1983 (all in current dollars).²¹ Space-based laser funding grew from \$57.8 million in fiscal year 1981 to \$139.4 million in 1983.²² The growth in Department of Defense funding emphasis for both BMD and ASATs (shown below as "space defense") is amply demonstrated in Figure 1.

	<u>Actual FY 82</u>	<u>Planned FY 83</u>	<u>Proposed FY 84</u>	<u>Proposed for FY 85</u>
BMD:				
Development	462.1	519.0	709.3	1,564.0
Procurement	--	--	--	--
Space Defense:				
Development	200.9	209.5	205.6	108.3
Procurement	--	--	19.4	196.9

Source: Department of Defense Authorization for Appropriations for Fiscal Year 1984, Hearings Before the Committee on Armed Services, US Senate, 98th Cong., 1st Sess., p. 337.

Figure 1. BMD and ASAT Expenditures from Fiscal 1982 to Fiscal 1985, in Millions of Dollars

Even more strikingly, the Department of Defense is seeking additional funds through 1988 for BMD and military uses of space, excluding communications, navigation, and weather satellites. According to Hallován, a 1983 Pentagon memorandum indicated that the Department of Defense would take \$10 billion over the next 5 years (1984-89) for research on defensive arms, including lasers, particle beams, microwave beams, and traditional missile-oriented defensive technologies. Of this \$10 billion, \$8 billion would be spent on land-based BMD, with \$2 billion allocated to space-based BMD. An additional \$6.3 billion would be requested for military uses of space, including funds for shuttle missions, space defense, surveillance and reconnaissance, and other active and passive uses of space, excluding communications, navigation, and weather satellites.²³ Since this memorandum was not identified as being for planning purposes or for final decision, and since the listed budget categories were sufficiently detailed to identify precise programs, far-reaching conclusions are uncertain. Nevertheless, one may safely conclude that the Department of Defense clearly intends to continue its BMD and space-related military activities.

Hence, rather than being viewed merely as a simple initiative, the strategic defense section of President Reagan's March 23d speech should be viewed as a clear indication of a growing emphasis in the American defense establishment on BMD and related space-based activity.²⁴ Beyond his March 23d address, Reagan's own interest and the country's commitment to BMD were institutionalized by the creation of an executive committee chaired by Secretary of Defense Caspar Weinberger to study BMD-related issues. By October 1983, Weinberger and the Defense Technologies Study Team had urged the President to support a 5-year, \$18 to \$27 billion program to develop space-based and land-based BMD capabilities for the defense of the United States and its allies.²⁵

SETTING THE STAGE: CATEGORIES OF BMD

BMD may be divided into two broad categories: passive and active. Passive defenses, which may be further divided into absorptive and evasive techniques, attempt to reduce the effects of a weapon on its target by increasing the target's ability to absorb punishment (absorptive defense) or by increasing the target's ability to avoid punishment (evasive defense). Neither method of passive defense will be addressed in this article.²⁶

Active defenses may also be subdivided into two categories, prelaunch defense and postlaunch defense. Prelaunch defense is synonymous with a damage-limiting preemptive attack against an enemy's strategic offensive forces. Preemptive attacks as a category of BMD also fall beyond the purview of this article. Here, we will deal only with postlaunch BMD, that is, the effort to prevent ballistic missiles already in flight from striking their intended targets." Thus, only one of several possible BMD categories will be examined.

Postlaunch active BMD may itself be further subdivided according to technologies and basing modes. Land-based BMD includes exoatmospheric ABM and endoatmosphere ABM of both nuclear and nonnuclear varieties, as well as DET weaponry, most prominently (because of technical reasons), particle beams. Space-based BMD includes DET weapons and homing vehicles." Sea-based and air-based BMD are also possible, but appear to present no significant advantages over space-based and land-based systems.

Despite the different technologies involved in each system, the problems that each must overcome are similar. All must identify the target, track it and verify its trajectory, overcome the target's countermeasures, attack the target, and finally, destroy, disable, or misdirect it. These are formidable tasks, and depending on which technical source one uses, the possibility of any BMD system accomplishing all of these tasks with a high degree of reliability ranges from "no way" pessimism to "can't miss" optimism.

Even the most optimistic proponents of BMD admit that a highly reliable system with low or no leakage will not be possible before the 21st century. President Reagan recognized this in his March 23d speech. Nevertheless, considerable optimism exists about the possibility of designing a moderately to highly reliable system, even where technologies have yet to be developed. Most BMD advocates maintain that the most effective BMD system would be a "layered" system consisting of several distinct components. In one such system, the first component would be a space-based system, probably a high energy laser, capable of engaging ascending international ballistic missiles (ICBMs) still in their boost phases before warhead separation occurs." Thus, in the case of ICBMs with multiple independently targetable reentry vehicles (MIRVs), several warheads would be destroyed by intercepting a single

missile, and the threat presented by MIRVs would be correspondingly lessened.

Any ICBMs that were not destroyed by the space-based system would be confronted by a second layer of defense, most probably a nonnuclear exoatmospheric ABM. Depending on the capabilities and design of the ABM, it could attack incoming targets either before or after warhead separation. Boost phase attacks, however, would be preferable, since the number of targets would be fewer.

The final component of a layered BMD system would be a low altitude nonnuclear endoatmospheric ABM (some scientists believe that land-based DET weapons eventually may be developed for close-in defense as well). Any warheads that penetrated the first two components of the system, proponents of BMD argue, would be intercepted and destroyed by a terminal defense system. Thus, it is argued, a sophisticated layered BMD system would have the same advantages of redundancy that add to the reliability of the American strategic retaliatory triad and might also be so structured to permit an overall leakage of about .1 percent.³⁰

Although a layered system would seemingly provide BMD with the least leakages, any single BMD component could be deployed by itself. Thus, a layered system is only the most sophisticated variant of several BMD alternatives.

BMD ISSUES AND IMPLICATIONS

Discussion following President Reagan's March 23d address raised a number of significant issues and implications related to BMD. The issues raised may usefully be divided into six major and interdependent areas: 1) technical feasibility; 2) cost-effectiveness; 3) the impact of BMD on arms race and crisis stability; 4) the implications of BMD for arms control agreements; 5) the effect of BMD on deterrence theory and strategic thought; and 6) the impact of BMD on the Western alliance.

Technical Feasibility. Even within the technical community, disagreement exists over whether a no-leakage or low-leakage BMD will ever be technically feasible. Most authorities, however, agree that a high-leakage or moderate leakage system could be developed. While this is not an appropriate forum to discuss the merits of the arguments that lead different authorities to different conclusions on the technical feasibility question, we can analyze some of the implications that follow from each level of reliability.

Thus, for example, some BMD critics often argue that only a perfectly reliable no-leakage system can guarantee safety of civilian population centers, and therefore BMD should be deployed only if such a system can be perfected. Even a single warhead would cause unprecedented death and destruction, they correctly argue, and therefore, unless a no-leakage BMD is perfected, no BMD makes sense.

This line of logic overlooks two points. First, even in the event of an attack on cities, a BMD that successfully intercepted all but a single warhead targeted against a major metropolitan area, such as New York City, would, in fact, significantly limit the damage the city suffered. The more porous (i.e., the easier the penetration) a BMD is, of course, the less this observation holds true. A BMD that failed to intercept five or six warheads targeted against diverse locations in New York City would, in fact, be virtually valueless. Nevertheless, the point to be made is simple: a low-leakage BMD system could be of some value in the defense of cities, or so-called countervalue targets.

Second, even a high-leakage BMD may be useful in the defense of America's retaliatory missile force (counterforce defense). In the event that future BMD technologies permit the destruction of only one of every two ICBMs in the boost phase and one of every two reentry vehicles (RVs) after warhead separation, a hypothetical attack against defended counterforce sites must employ twice as many ICBMs and RVs as in an attack on an undefended site to achieve the same level of target destruction. Since the purpose of a large-scale counterforce attack would be to disarm an enemy, it is reasonable to assume that even a high-leakage counterforce defense would have one of two effects. First, it may goad the potential attacker into increasing the size of his strategic offensive forces, thereby creating an offensive-defensive arms race and thereby raising questions of cost-effectiveness examined below. Second, it may increase the uncertainty of a potential attacker about the possibility of a successful disarming first strike, thereby influencing him not to strike. Assuming one places credence in the possibility of a disarming first strike, under certain crisis scenarios, deterrence would therefore be enhanced by even a high-leakage BMD."

Additionally, a high-leakage or even a no-leakage BMD deployed for counterforce defense would provide little incentive to the side that had it to initiate a disarming first strike, if simply

because its BMD defended targets would themselves be gone in the event that it launched a first strike. In this scenario, BMD would be meaningless.

This logic runs into difficulty, however, if a low- or no-leakage BMD could be used to defend counterforce or countervalue targets. Space-based BMD may well be such a system. With such a capability, a scenario could be foreseen in which a national command authority would gamble that were it to launch a highly successful disarming first strike, its space-based BMD could cope with the degraded countervalue retaliatory strike. In this situation, both sides would have an incentive to strike first. Conversely, if space-based BMD had a moderate leakage or high-leakage rate, such logic would not be possible. Counterforce BMD would be somewhat improved, and countervalue BMD would be of low quality. Thus, a moderate leakage or high-leakage space-based BMD may be preferable to a low- or no-leakage BMD, at least from the viewpoint of crisis stability.

Inherent technical factors also have a significant impact on the effectiveness of BMD defense systems. For land-based BMD, the responsiveness of the system, the number of interceptors available, and the ability of ABM radars, C³, and other associated hardware and software to withstand detonation shocks, electromagnetic pulse (EMP), and other effects of an attack are critical. A space-based system also must be able to withstand these effects, in addition to other challenges. A space-based system would be in a position where an opponent could use its ASAT capabilities to destroy or degrade it. Hence, space-based BMD must itself be defended, which most suitably would be by built-in technical defensive capabilities.

Proponents of space-based BMD assert that such a system could defend itself just as it defends against missiles. However, this argument overlooks three points. First, if an enemy were to develop DET weapons, space-based BMD would itself be subject to both land-based and space-based DET attack. Such an attack would not necessarily have to destroy the BMD's orbital platform, but would merely have to degrade the ability of the space-based unit to identify, track, or perform any of the tasks necessary in the BMD process. Indeed, the US Department of Defense fears that the USSR may already have developed and tested a rudimentary DET anti-satellite capability.²² Laser versus laser battles in space may be

the stuff of science fiction literature, but advocates of space-based BMD must also recognize the utility of an adversaries' DET weapons against US space-based assets. Even a space-based laser would have great difficulty in defending itself against a DET weapon that attacked it first.

A second obstacle to effective defense of space-based BMD is direct ascent ASAT technology. Direct ascent ASAT has a smaller boost phase signature than that of an ICBM in boost phase; it is in this phase for a shorter period of time; and it may also accelerate more rapidly than an ascending ICBM. Space-based BMD systems must, therefore, be more sensitive and more responsive than their anti-ICBM tasks require if they are to successfully defend themselves against direct ascent ASAT weapons.

A third obstacle to defense of space-based BMD is space mine technology. As most commonly envisioned, space mines would be lofted into a coorbital position near space-based BMD platforms where they would then passively remain until an opponent's national command authority decided to detonate them to destroy the BMD platform.³³ Two solutions to this problem appear plausible. First, space-based BMDs could be programmed to destroy anything that came within a given distance. Such actions, of course, could lead to war. A second option could be to negotiate an international agreement in which all sides agreed not to introduce other satellites to or near positions in space that are already occupied.

The problem presented by the need to defend space-based BMD is somewhat reduced by the fact that any large-scale attack on the system would provide strategic warning time to the nation whose space assets had been attacked. The strategic warning time afforded by such an attack, however, might be compressed into meaninglessness if one's adversary simultaneously initiated an ASAT attack and launched a counterforce first-strike with his strategic offensive forces. Smaller attacks, moreover, would be more difficult to read, and would, therefore, present less unambiguous warning.

Would BMD be effective against depressed trajectory submarine-launched ballistic missiles (SLBMs) and other strategic offensive systems? Depressed trajectory SLBMs and other shorter range missiles such as the SS-20³⁴ present special difficulties to BMD because of their shorter flight times. System responsiveness

would, therefore, have to be more rapid to cope with such offensive systems. BMD systems would not, of course, be designed to cope with other strategic offensive systems such as cruise missiles and intercontinental bombers, although it is possible that space-based BMD may have some utility against them as well.¹⁵

What one concludes about the technical feasibility of BMD at the present time is essentially a function of what one hopes BMD will accomplish. Only a leak-proof system could provide a perfectly reliable defense against all forms of strategic offensive delivery vehicles, and such a system will be difficult to develop, deploy, maintain, and operate. If one hopes for a perfect defense, then, one is likely to be disappointed. Below perfection, however, different levels of leakage carry with them different arguments for and against deployment. Barring development of a perfectly reliable BMD, then, this analysis of the implications of technical feasibility drives one to ambiguous conclusions. Given certain capabilities and certain deployment patterns, BMD could improve American and Western security. Given other capabilities and deployments, it would not.

Cost-Effectiveness. BMD cost-effectiveness has been criticized from two different perspectives. The first argues that an effective BMD will cost hundreds of billions of dollars, and therefore, even if BMD is technically feasible, it will be too costly to deploy, operate, and maintain. Much of the cost that would accompany space-based BMD results from the necessity to orbit a sizeable number of BMD platforms. Such platforms, it is generally conceded, must be in low earth orbit to be effective. This fact stems from the propensity of beams to disperse over distance, and from the need for relatively "slow" ABM weapons to be near their intended targets. Therefore, space-based BMD platforms will not be in geosynchronous orbit, and, consequently a large number of BMD platforms would need to be orbited to achieve constant coverage of ICBM, much less SLBM, launch sites. According to one analysis of a space-based laser defense system, as many as 700 satellites with 5-megawatt lasers would have to be orbited to produce effective constant coverage of the current generation of Soviet missiles.¹⁶ Even as ardent an advocate of space-based defense as retired Army Lieutenant General Daniel O. Graham sees a necessity to have 432 operational satellites, each armed with 50 miniature homing vehicles to provide effective constant coverage of

Soviet launch sites.³⁷ While Graham projects the cost of deploying his satellites as only \$10 to \$15 billion, most other estimates are several times his total. Indeed, given the uncertainties of the technologies involved in space-based missile defense, any cost projection is highly speculative. However, the initial deployment costs of a space-based missile defense would very likely require tens of billions of dollars at a minimum. Operation and maintenance would add billions of dollars more to the total cost.

A land-based BMD would probably cost less than space-based BMD, but would not by itself have the latter's advantages of boost-phase interception. Thus, unless intercept took place before warhead separation occurred, the number of targets would have multiplied, and the likelihood would increase that at least some warheads would penetrate the defenses to reach their targets. A BMD without space-based components would, therefore, probably be more porous than one with space-based components.

A second criticism of the cost-effectiveness of BMD argues that offensive efforts to penetrate a deployed BMD system would be less costly than efforts to upgrade the deployed BMD system's ability to counter the offense's penetration aids. Thus, it is argued, the defense would always have to spend more to overcome offensive advances than the offense would have to spend to overcome improved defensive capabilities. If this is true, it clearly places any BMD at a distinct cost effectiveness disadvantage in an offensive-defensive cost spiral.

Types of potential penetration aids vary. Hardening the skins of ICBMs is one penetration enhancement option. If ICBMs were hardened, DET weapons would either have to dwell longer on a target to destroy it, or increase the energy of the beam they project. The effect of an ICBM hardening program on a space-based laser defensive system is well illustrated by Figure 2. Assumptions include that constant coverage of launch sites is desired; that the number of ICBMs deployed remains constant at about 1500; and that only missile hardness is used as a penetration enhancement device. Would it cost more to deploy, operate, and maintain the requisite number of space-based lasers than it would cost one's opponent to harden his ICBM arsenal? Again, only speculation is possible.

While hardening may be a cost-effective method of overcoming DET BMD, hardening would provide little penetration

<u>Laser Type</u>	<u>Missile Hardness (in Joules/cm²)</u>	<u>Space-Based Lasers Required</u>
5 Megawatts	Soft (300)	700
	Medium (2,000)	4,700
	Hard (20,000)	
10 Megawatts	Soft (300)	55
	Medium (2,000)	400
	Hard (20,000)	4,000

Source: Derived from Daniel Kaplan, "Lasers for Missile Defense."

Figure 2. Number of Space-Based Lasers Required to Provide Constant Launch Site Coverage, According to Different ICBM Hardness.

enhancement against ABMs. Even so, penetration aids such as maneuverable reentry vehicles (MaRVs) could present difficulties for ABMs. MaRVs hope to overcome ABMs by altering the ballistic trajectory of the incoming reentry vehicle (P. 7). An ABM's task of arriving at a predetermined point on a ballistic trajectory at the same instant as the incoming RV is, therefore, rendered impossible for the simple reason that the RV is no longer on that trajectory. Once again, the race would be on between the cost of adding MaRVs to MIRVs and the cost of upgrading ABM capabilities to cope with maneuverability, with the cost-effectiveness winner uncertain at this time.

Even the simplistic penetration enhancement option of overloading a space-based, land-based, or layered BMD system does not present as clear a picture of offensive advantage as is sometimes imagined. To a great extent, the ability to overload a BMD system is determined by the capabilities of the system. Thus, a low-leakage BMD would force a potential attacker to deploy significantly greater numbers of ICBMs than a high-leakage system. Whether or not a potential attacker could derive a cost-effective advantage by seeking to penetrate a BMD by overloading it is determined, therefore, by the BMD capabilities.

In the event that a low-leakage BMD is deployed, a national command authority may opt to enhance its strategic offensive forces' abilities to penetrate a BMD by increasingly deploying air-breathing delivery vehicles such as cruise missiles. At the present

time, how effective BMD, in general, would be against such targets is uncertain. Nevertheless, such a change in offensive force structure would have significant implications for crisis stability and deterrence and will be explored below.

Unfortunately, this discussion of cost-effectiveness, like the discussion of technical feasibility, offers no definitive conclusions about the wisdom of future BMD deployment. Costs will be unknown but great, and an expenditure spiral of offensive penetration and countering defensive improvements appears probable. However, which side would enjoy a cost-effectiveness advantage or even whether such calculations have meaning on such an environment is far from certain at this time.

Crisis Stability and Arms Race Stability. The concept of crisis stability refers to a condition in which during a crisis situation neither side perceives a necessity for the immediate employment of its weapons for fear of a preemptive strike by its adversary. In simpler terms, crisis stability exists when a national command authority does not feel pressured to "use 'em or lose 'em," with " 'em" referring to its strategic offensive delivery vehicles. By comparison, arms race stability is the condition that exists when neither side considers it necessary to introduce new channels to the arms race or to increase significantly its present rates of military expenditure. BMD deployment has major implications for both crisis and arms race stability.

The implications that BMD deployment would have for crisis stability are functions of the timing, location, and effectiveness of BMD deployment. In many scenarios, BMD deployment would reduce the first-strike incentive of the side that first deployed BMD. This would be particularly true if a low-leakage BMD system were deployed in defense of strategic retaliatory forces because the possibility of an attempted disarming first strike being successful will decrease as the degree of leakage of the BMD system decreases. Thus, a national command authority's belief in its ability to launch an assured second strike would be improved if it had a low-leakage BMD system defending its retaliatory forces. Additionally, as previously discussed, BMD deployed in defense of counterforce assets would not influence the deploying side to launch a first strike because its countervalue assets—cities—would remain unprotected. BMD deployed in defense of strategic delivery vehicles should then contribute to crisis stability to the extent that it adds uncertainty to

the ability of an attacker to successfully carry out a disarming first strike.³¹

Two caveats are necessary. First, BMD deployed in defense of countervalue assets would probably be destabilizing in a crisis scenario. If a low-leakage BMD were deployed to protect countervalue targets, the deploying sides' national command authority may initiate a first strike if it had confidence in the combination of its strategic offensive forces' abilities to destroy a significant percentage of an enemy's nuclear capabilities and of its BMD's abilities to defeat those forces that survived. In this scenario, a low-leakage BMD deployed in defense of countervalue assets would undermine crisis stability. Indeed, both sides may well perceive a necessity to strike first.

The second caveat relates directly to space-based BMD. By its nature, space-based BMD provides protection to both counterforce and countervalue assets. Thus, inevitably, its impact on crisis stability would be ambiguous. On the one hand, a national command authority with confidence in its space-based BMD would not feel pressured to launch its missiles in a crisis, for they would be protected. On the other hand, a national command authority with confidence in its space-based BMD may feel confident enough to initiate a disarming first strike, with its BMD to be used to destroy surviving retaliatory forces. Here, crisis stability would be undermined.

Two other aspects of the implications of BMD for crisis stability deserve comment. First, assuming that deployment of a large-scale BMD system could not proceed in secrecy, the national command authority of a country that trailed in a "BMD race" could be placed in a position of "use 'em or leave 'em useless" with reference to its ICBM or SLBM forces. Would a national leadership placed in such a situation, in fact, sit meekly by and watch construction of a BMD system that rendered its nuclear forces impotent? Or would it seek to frustrate the deployment of its rivals' BMD? Failing that and fearing a "win now, lose later" situation, would it even consider using its missiles before they become useless? Care should be taken not to overstate the case, however, that the deployment of a BMD system has a potential for generating a major crisis in and of itself.

Interestingly, President Reagan suggested one way to avoid the crisis that might almost inevitably result from a unilateral BMD

deployment. In a late March 1983 interview with selected newspaper columnists at the White House, Reagan speculated on the possibility that a president:

... could offer to give ... defensive weapons to (the Soviets) to prove to them that there was no longer any need for keeping these missiles."

Whether such an offer would ever be feasible in the context of American politics is, of course, an open question. Nevertheless, shortly after Reagan's interview was published, the Soviet government proposed that US and Soviet scientists meet to discuss "possible implications of establishing a large-scale ABM system." The United States responded affirmatively to the Soviet suggestion in mid-July 1983.⁴⁰

The course of such talks, if and when they fruitfully conclude, will largely determine the impact that BMD will have on arms race stability. As pointed out earlier, the United States is increasingly committing itself to BMD development, and there is every reason to believe the USSR is doing the same. Thus, in the event of failure of the proposed BMD talks, arms race instability in ballistic missile defense systems appears guaranteed. Moreover, there is some probability that an offensive-defensive expenditure spiral will be forthcoming as well.

The second aspect that deserves comment is the effect that a highly capable space-based BMD with limited endoatmospheric abilities could have on crisis stability. If such a system were developed and deployed, current generations of ICBMs and SLBMs would have reduced utility, and national authorities may opt to restructure their strategic delivery forces to emphasize bombers and air- and sea-launched cruise missiles. The current major threat to crisis stability is the great speed of highly accurate ICBMs and SLBMs. Restructuring toward less time-urgent systems, brought about by space-based BMD, would, in fact, add to crisis stability. Again, however, a renewed arms race in anti-aircraft and anti-cruise capabilities may be the result.

BMD and International Treaties. Three treaties—the 1967 multilateral "Outer Space" Treaty, the 1972 "US-Soviet ABM" Treaty, and the 1974 "US-Soviet ABM" Protocol—could conceivably be affected by a newly deployed BMD system. Specifically, the Outer Space Treaty prohibits the stationing of

nuclear weapons and other "weapons of mass destruction" in space; the ABM Treaty prohibits the development, testing, and deployment of space-based ABM systems or components, and, in an agreed statement, notes that BMD systems "based on other physical principles" "would be subject to discussion" by the Standing Consultative Commission established by the treaty; and the 1984 Protocol limits the United States and the Soviet Union, each, to one ABM site located either at its national capital or at a single ICBM launch site.

There is little disagreement that deployment of a large-scale BMD system will necessitate revision of some aspects of the ABM Treaty and, depending on the technologies deployed, possibly the Outer Space Treaty. While some may question whether DET weapons should be defined as weapons of mass destruction, even Caspar Weinberger has recognized that large-scale BMD deployment "may necessitate" an update of the ABM Treaty.⁴¹ Even with this recognition, however, the United States assured the Soviet Union shortly after Reagan's March speech that the speech "in no way" should be interpreted as reducing the US commitment to the ABM Treaty.⁴²

Short of a withdrawal from the treaty by either of the parties, revision of the treaty would probably take place under the auspices of the Standing Consultative Commission. Negotiations would occur either in a special session or during one of the review periods mandated at five-year intervals by the Treaty. Indeed, when the United States indicated its willingness to begin scientific discussions with the USSR over the implications of BMD, the United States insisted that those discussions be held either in the context of the Standing Consultative Commission or of the ongoing Strategic Arms Reduction Talks. Whether mutually satisfactory BMD agreements could be negotiated or ratified is a tendentious question.

Strategic Thought and Deterrence Theory. An operational BMD system would have a major impact on strategic thought in general and deterrence theory in particular. Throughout most of the nuclear age, deterrence theory has been based on the certainty of retaliation. Ultimately, this meant that if the Soviet Union launched a first strike on the United States, the United States would retain enough of its strategic forces to render the USSR inoperative as a functioning modern society. In recent years, however, the

expansion of Soviet nuclear capabilities and the development of highly accurate MIRVs have undermined the certainty of deterrence as some strategic theorists calculated that disarming first strikes may now be possible.

However, if BMD were deployed, new elements of attack uncertainty would be interjected into such calculations.³ While highly accurate MIRVs introduced a level of certainty into counterforce strike planning, BMD could reduce this destabilizing level of certainty. Even with a high-leakage BMD, planners contemplating a disarming first strike would have to ask the question: "What if the BMD is more effective than we project?" Thus, uncertainty again could play a larger role in deterrence.

BMD would also have a major impact on the attractiveness of theories of nuclear war-fighting. If one or both sides were increasingly uncertain about whether its warheads would reach their targets, the likelihood that strategic forces would be used to achieve a particular military objective would probably be reduced. The growth of uncertainty brought about by deploying a BMD may, therefore, negate the feasibility of war-fighting strategies made possible by MIRVs and great accuracy.

It must be reemphasized that the key factor in determining the impact of BMD on deterrence is whether a potential opponent would view BMD as a threat to the utility of his retaliatory forces. If any BMD were deployed so that all counterforce assets were protected, no opponent could realistically view his ability to deliver a successful retaliatory attack as being jeopardized. Conversely, if a moderate-, low-, or no-leakage BMD were deployed to defend countervalue assets, a potential enemy might conclude that the deploying side was seeking to attain a retaliation-free first strike capability. Such a perception could be disastrous for deterrence. This differentiation has serious implications for space-based defense. A potential enemy could not discriminate between space-based BMD intended for counterforce defense and space-based BMD intended for countervalue defense. In this sense, land-based BMD appears clearly preferable to its space-based counterpart. The tradeoff, however, is that a low- or no-leakage land-based BMD is likely to be more difficult and more costly to achieve.

BMD and the Western Alliance. What effect would BMD have on our NATO and Japanese allies? The answer depends on the type and capability of the system deployed. If a BMD were deployed

that provided the same level of protection to alliance countervalue targets (cities) as it did for American countervalue targets, little reason exists to imagine that alliance views of BMD would be different from American views. However, if less BMD protection were afforded to foreign cities than to those of the United States, the impact on the Western alliance could be immense.

Throughout the nuclear era, the defense of Europe and Japan has been coupled directly to the American strategic nuclear arsenal. Any Soviet aggression in either theater invited, as a last resort, American nuclear response. As the USSR developed its own nuclear delivery capabilities, thereby holding the United States at greater risk, American willingness to use nuclear weapons in defense of its allies became less credible. American allies responded to this new situation in various ways. Some ignored the implications of US vulnerability and continued to rely upon collective security; some sought their own nuclear deterrent; others emphasized indigenous conventional forces; and still others stressed the necessity for peaceful relations with the Soviet Union.

BMD deployment would lead inevitably to readjustments of policy. While the elimination of American vulnerability to nuclear attack could, on the one hand, renew allied faith in the credibility of the American deterrent, it could also point out to United States allies that they remained vulnerable, while the United States pursued the destabilized and dangerous goal of military superiority. Given the vagaries of international politics, such a perception might lead to one of two distressing possibilities: neutralization in Europe and Japan or the upgrading or creation of European and Japanese nuclear retaliatory forces. Here, it should be remembered that Great Britain, in particular, strongly opposed large-scale BMD deployment during US-Soviet SALT I negotiations because BMD threatened to degrade the credibility of Great Britain's nuclear deterrent.⁴⁴

Conversely, if BMD deployment were undertaken around US ICBM sites, a Japanese and European response may be more muted. Currently, the United States believes there is a higher potential for a Soviet disarming first strike during an intense crisis than do the American allies. Any American defense of its own strategic forces would probably be seen as simply a US effort to meet a peculiarly American fear, but an effort which, nevertheless, would have only limited implications for its allies. One would

expect similar perceptions within the Warsaw Pact if the USSR were to deploy BMD to protect its ICBM forces.

However, in the event that the USSR were to deploy unilaterally a low-leakage or no-leakage BMD, protecting countervalue sites, the Western alliance undoubtedly would be shaken. Europeans and Japanese, already feeling vulnerable in the current strategic environment, would become even more so. America's strategic deterrent, then, would have even less credibility. In this scenario, "Finlandization" would become increasingly attractive to Europeans and Japanese.

CONCLUSIONS

Ballistic Missile Defense clearly presents American and Western security planners with a staggering number of possibilities. The uncertainties pertaining to future BMD technologies as well as the unknown constraints of deployment and operational costs make acquisition decisions highly problematic. As a result, neither the proponents nor opponents of BMD in space-based, land-based, or layered deployment modes present evidence that drives one to an unambiguous set of final conclusions.

But some observations are in order. First, all American assessments of BMD must proceed not only from the vantage point of American intentions, but also from the outlook of Soviet perceptions. Soviet security planners cannot and will not accept United States assurances that the development of BMD was intended to protect the United States against a Soviet first strike, rather than providing the United States the means to launch its own first strike against the USSR. To the Soviet planner, American efforts to develop BMD carry with them all of the implied dangers of an American drive for strategic superiority; these, of course, are the same dangers that American planners perceive in corresponding Soviet efforts. The second observation relates specifically to the fact that space-based BMD could be used for either counterforce or countervalue defense. Since no planner can verify that an opponent would limit his space-based BMD to counterforce defense, all planners must view an opponent's space-based BMD as an adjunct to his offensive forces. Thus, unless both sides can arrive at a space-based BMD regime simultaneously, space-based BMD inevitably must appear destabilizing to the side that trails in its

deployment. With the dangers that instability presents, either simultaneous deployment or nondeployment of space-based BMD appears preferable to any nonsymmetrical deployment.⁴⁵

Beyond prevention of increased strategic instability, what advantages would accrue to simultaneous deployment or nondeployment? Assuming that either a low-leakage or no-leakage system can be developed, simultaneous deployment could lead to a reduction of the nuclear threat facing the superpowers. From the perspectives of both the United States and the Soviet Union, this would of course be desirable. (Third countries such as China may be expected to have a significantly different perspective, however.) However, if only a moderate- or high-leakage system becomes technically feasible, no additional advantages become apparent. The second option, a decision to forego space-based BMD, clearly carries with it a considerable cost savings as well as the advantage that neither side could attempt to punch holes in the other's space-based BMD system with a surprise coordinated DET and ICBM attack in an effort to gain strategic superiority. These are both considerable advantages, but they can only be attained through a negotiated decision not to deploy such defensive systems.

Indeed, the single most persuasive argument for space-based BMD is that it provides the opportunity to intercept and destroy an opponent's ICBMs which incorporate MIRVs in the boost phase before warhead separation occurs. However, if the United States and the Soviet Union were to build and deploy the small, single RV ICBMs advocated by the President's Commission on Strategic Forces (the so-called Scowcroft Commission),⁴⁶ one of the strongest rationales for space-based BMD would be removed.

A third observation relates specifically to land-based BMD deployed for counterforce defense. The preceding analysis suggests that under most conditions, possession by both sides of a counterforce or "point" BMD enhances stability since it increases the uncertainties that a first strike could be disarming. Conversely, land-based BMD deployed for countervalue defense suggests that instability would increase because of the linkage that could occur in an opponent's eyes between an offensive first strike and a countervalue defensive effort.

As usual, however, the choices the United States is likely to face are not limited to the relatively easy ones of space-based defense versus land-based defense, or of countervalue defense versus

counterforce defense. Given the emphasis that both the United States and the Soviet Union are placing on space- and land-based systems using both conventional and DET technologies, the most likely future choices, undoubtedly, will include mixes of both technologies and both basing modes. It is imperative, then, as the capabilities and costs of BMD and space-based defense become clearer, that strategy be developed along with technology. To do what is technologically feasible while giving only limited thought to the implications that technologies carry with them is to repeat what has been done too often in the past. Deploying military technologies without careful consideration of the implications of their deployment too often has led not to an increase in security, but to an increase in threat. BMD and space-based defenses, then, are the same two-edged swords that H-bombs and MIRVs have become.

ENDNOTES

1. Transcript of President Ronald Reagan's March 23 speech on military spending, *The New York Times*, March 24, 1983, p. 20.
2. For a sampling of reaction to Reagan's speech, see Patrick Callahan, "The Delusion of Defense Once Again," *America*, April 30, 1983, pp. 340-41; Thomas H. Karas, "The Star Wars Scenario," *The Nation*, April 9, 1983, pp. 444-445; Daniel Kaplan, "Lasers for Missile Defense," *Bulletin of the Atomic Scientists*, May 1983, pp. 5-9; and Charles Mohr, "Scientists Dubious Over Missile Plan," *The New York Times*, March 25, 1983, p. A8.
3. See, for example, Abram Chayes and Jerome B. Weisner, eds., *ABM: An Evaluation of the Decision to Deploy an Antiballistic Missile System*, New York: Harper and Row, 1969.
4. Donald M. Snow, *The Nuclear Future: Toward a Strategy of Uncertainty*, University, Alabama: University of Alabama, 1983, p. 86.
5. For one detailed discussion of a layered BMD system that combines space-based DET and conventional weapons with land-based ABM capabilities, see the Heritage Foundation's "High Frontiers" study, contained in *Department of Defense Authorization for Appropriations for Fiscal Year 1983: Hearings before the Committee on Armed Services*, US Senate, 97th Cong. 2d sess., pp. 4884-4904.
6. For texts of both, see US Arms Control and Disarmament Agency (ACDA), *Arms Control and Disarmament Agreements*, Washington: 1982, pp. 139-142, and pp. 162-163, respectively.
7. E. C. Aldridge, Jr., and Robert L. Maust, Jr., "SALT Implications of BMD Options," in Michelle Marcouiller, ed., *US Arms Control Objectives and the Implications for Ballistic Missile Defense: Proceedings of a Symposium Held at the Center for Science and International Affairs, Harvard University, November 1-2, 1979*, Cambridge: Center for Science and International Affairs, 1980, pp. 55-56.
8. "Airborne Laser Disables Missiles in Air Force Test," *The Washington Post*, July 26, 1983, p. A5; and "Army to Flight Test Non-nuclear ABM," *Aviation Week and Space Technology*, January 24, 1983, pp. 30-31.
9. Richard Halloran, "Military Divided Over Space Policy," *The New York Times*, July 5, 1983, p. 11.
10. For the complete text of the Outer Space Treaty, see ACDA, pp. 510-555.
11. *Department of Defense Authorization for Appropriation for Fiscal Year 1984, Hearings before the Committee on Armed Services*. US Senate, 98th Cong., 1st sess., p. 488.
12. The Soviet Union, it should be noted, is developing its own version of the space shuttle, although it is several years behind the United States.
13. *Department of Defense Appropriations for Fiscal Year 1983: Hearing before the Committee on Appropriations*, US Senate 97th Cong., 2d sess., p. 558.
14. Governmental space and BMD activity was paralleled by expanded private research and publishing in the fields. From 1981 to early 1983 alone, at least six books were published on the military uses of space. The books of differing quality and ideological outlook, are David Baker, *The Shape of Wars to Come*, New York: Stein and Day, 1982; Bhupendra Jasani, ed., *Outer Space—A New Dimension of the Arms Race*, Cambridge: Taylor and Frances, 1982; Thomas Karas, *The New High Ground*, New York: Simon and Schuster, 1983; David Ritchie, *Spacewar*, New York: Atheneum, 1982; and G. Harry Stine, *Confrontation in Space*, Englewood Cliffs: Prentice Hall, 1981.

15. Richard Halloran, "US Military Operations in Space to be Expanded Under Air Force," *The New York Times*, June 22, 1982, p. A19.
16. Brad Knickerbocker, "Space Race Takes Military Turn," *Christian Science Monitor*, May 26, 1982, p. 1.
17. "Reagan Policy Expected to Aid Space Station Definition Work," *Aviation Week and Space Technology*, July 12, 1982. See also "Air Force Space Plan to Orr This Week," *Defense Week*, July 5, 1983, pp. 1, 19d.
18. These events are detailed in "Air Force to Orr This Week," *Defense Week*, July 5, 1983, pp. 1, 19; Halloran, "US Military Operations in Space to be Expanded under Air Force;" and Clarence A. Robinson, "Defense Department Backs Space-Based Missile Defense," *Aviation Week and Space Technology*, September 27, 1982, pp. 14-16.
19. Gelb, *The New York Times*, March 25, 1983, p. A1.
20. Halloran, "Air Force Seeking Joint Space Unit," *The New York Times*, June 19, 1983, p. A17.
21. *Department of Defense Authorization for Appropriations, for Fiscal Year 1983*, US Senate, 97th Cong., 2d sess., p. 4854.
22. *Department of Defense Appropriations for Fiscal Year 1983*, p. 601.
23. Halloran, "Pentagon Seeking More in Research," *The New York Times*, April 14, 1983, p. A13.
24. None of the preceding discussion should be interpreted to imply that previous administrations completely ignore BMD and the military implications of space. Jimmy Carter's space policy, for example, was set forth in Presidential Decision 37. See "Space Policy Directive Broadens Civil Programs," *Aviation Week and Space Technology*, May 29, 1978, p. 23; Richard D. Lyons, "Administration Discloses Plans for Use of Space Technology," *The New York Times*, June 20, 1978, p. 84; "Space Policy Bills Prepared for Introduction," *Aviation Week and Space Technology*, September 25, 1978, p. 14; and Robert Hotz, "Space Policy Debate," *Aviation Week and Space Technology*, December 4, 1978, p. 11.
25. "Panel on Missile Defense," *The New York Times*, April 2, 1983, p. A38; and Clarence A. Robinson, Jr., "Panel Urges Defense Technology Advances," *Aviation Week and Space Technology*, October 17, 1983, pp. 16-18.
26. These differentiations may be found in Snow, pp. 68-69, 86-88.
27. *Ibid.*
28. For a discussion of the latter, see the Heritage Foundation's "High Frontier" study.
29. Warhead separation refers to the separation of MIRVs from the MIRV-ejection platform, or "bus."
30. See Robinson, Jr., "Panel Urges Defense Technology," p. 16.
31. BMD success rates can be leveraged beyond the leakage rate of the system if BMD is combined with deceptive basing. For example, a single LoADS unit deployed to defend the single shelter where an ICBM was housed in a multiple protective shelter (MPS) basing system would force multiple targeting of every protective shelter. For a discussion of the cumulative effects of LoADS and MPS, see Raymond E. Starsman, *Ballistic Missile Defense and Deceptive Basing: A New Calculus for the Defense of ICBMs*, *The National Defense University Monograph Series 81-1*, Washington: NDU Press, 1981.
32. Richard Burt, "US Says Russians Develop Satellite-Killing Laser," *The New York Times*, May 22, 1980, p. A9.

33. For references to space mines see John Noble Wilford, "Despite 1967 US-Soviet Treaty, Drive for Space Weapons Goes On," *The New York Times*, March 27, 1983, pp. A1, A14.

34. From a Soviet perspective, this would be true of the US Pershing II.

35. US Air Force Chief of Research and Development, Lieutenant General Kelley Burke, raised this possibility shortly after President Reagan's March 23d address, when he noted that the USSR could orbit an antiaircraft satellite weapon by the end of the 1980's. See "Soviet Speed, US Outlook, in Laser Weapons Reported," *Christian Science Monitor*, April 23, 1982, p. 2.

36. See Daniel Kaplan, "Lasers for Missile Defense," *Bulletin of the Atomic Scientists*, May 1983, pp. 5-9.

37. See the "High Frontiers" study.

38. For more detailed discussion of what has been termed "a strategy of uncertainty," see Snow, pp. 122-167.

39. "Transcript of Group Interview with President at White House," *The New York Times*, March 30, 1983, p. A14.

40. Charles W. Corrdry, "Soviets Seek Talks on 'Star Wars' Plan," *Baltimore Sun*, June 18, 1983, p. 1; and Walter Pincus, "Soviets Told US Ready for Space-Arms Talks," *The Washington Post*, July 14, 1983, p. A18.

41. John Darnton, "Weinberger Says ABM Pact May Ultimately Need Amending," *The New York Times*, March 25, 1983, p. A9.

42. Bernard Gwertzman, "Soviet Told by US ABM Pact Stand," *The New York Times*, March 27, 1983, p. A1.

43. Snow, pp. 122-167.

44. Christopher Makins, "Bring in the Allies," *Foreign Policy*, Summer 1979, p. 97.

45. This observation raises a difficult question that extends beyond the scope of this paper, but which nevertheless must be raised here. Put simply, the question is, how, in the event of simultaneous deployment, should BMD systems be structured so that they provide equal security to nonsymmetrical strategic nuclear forces?

46. See "Report of the President's Commission on Strategic Forces," Washington: US Government Printing Office, 1983.

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21. ABSTRACT (Continue on reverse side if necessary and identify by block number) This memorandum examines the many issues related to the technical feasibility and future deterrent utility of ballistic missile defense (BMD). The author contends that BMD clearly presents American and Western security planners with a staggering number of possibilities. The author concludes, however, that uncertainties pertaining to future BMD technologies, the unknown constraints of deployment, and the potential costs make acquisition decisions highly problematic. Neither proponents nor opponents of space-based, land-based, or layered BMD systems have presented evidence that drives one to unambiguous final conclusions.		

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